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The role of Azerbaijan's energy sector in the implementation of economic reforms in modern conditions

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Abstract. The energy sector is one of the main driving forces of modern economic development. Energy resource management, renewable energy development and energy security play a decisive role in the successful implementation of economic reforms. Many countries use oil and gas revenues to build infrastructure and diversify their economies. At the same time, the development of renewable energy sources, the transition to a green economy and increased energy efficiency are among the main areas of modern reforms. Uninterruptible power supplies ensure the smooth operation of industrial enterprises. Dependence on oil, costly technological transition and political risks are the main problems faced by the energy sector. However, the introduction of digital technologies, expanded international cooperation and the development of alternative energy sources help to solve these problems. Reforms in the energy sector strengthen the country's energy security, reduce external dependence and increase national economic independence. At the same time, the energy sector creates new jobs, contributes to the modernization of the labor market and improves social welfare. Energy reforms ensure long-term economic development and increase the country's global competitiveness. The energy sector is an integral part of the modern economy in terms of industrial modernization, innovation and environmental sustainability.

Keywords: energy, digital technologies, innovation, economic reforms, technological transition, renewable energy

Highlights:

- ♦ revenues from oil and gas exports act as a financial guarantee for economic diversification and support investment in the non-oil sector;
- ♦ upgrading energy infrastructure and technological modernization create conditions for accelerating reforms and maintaining economic stability;
- ♦ the use of alternative energy sources within the framework of economic reforms increases energy security and reduces the impact on the environment;
- ♦ the energy sector plays an important role in attracting foreign investment, forming the trade balance and integrating into global energy markets.

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Роль энергетического сектора Азербайджана в реализации экономических реформ в современных условиях

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Аннотация. Энергетическая отрасль является одной из основных движущих сил современного экономического развития. Управление энергетическими ресурсами, развитие возобновляемых источников энергии и энергетическая безопасность играют решающую роль в успешной реализации экономических реформ. Многие страны направляют доходы от добычи нефти и газа на строительство инфраструктуры и диверсификацию экономики. При этом развитие возобновляемых источников энергии, переход к «зеленой» экономике, повышение энергоэффективности являются одними из основных направлений современных реформ. Источники бесперебойного питания обеспечивают стабильную работу промышленных предприятий. Зависимость от нефти, дорогостоящий технологический переход и политические риски – вот основные проблемы, с которыми сталкивается энергетический сектор. Однако внедрение цифровых технологий, расширение международного сотрудничества, развитие альтернативных источников энергии помогают решить эти проблемы. Реформы в энергетическом секторе укрепляют энергетическую безопасность страны, снижают внешнюю зависимость и повышают национальную экономическую независимость. В то же время энергетический сектор создает новые рабочие места, способствует модернизации рынка труда и повышает социальное благосостояние. Реформы в энергетике обеспечивают долгосрочное экономическое развитие и повышают глобальную конкурентоспособность страны. Энергетический сектор является неотъемлемой частью современной экономики с точки зрения промышленной модернизации, инноваций и экологической устойчивости.

Ключевые слова: энергетика, цифровые технологии, инновации, экономические реформы, технологический переход, возобновляемая энергетика

Основные положения:

- ♦ доходы от экспорта нефти и газа выступают финансовым гарантом диверсификации экономики и поддерживают инвестиции в ненефтяной сектор;
- ♦ обновление энергетической инфраструктуры и технологическая модернизация создают условия для ускорения реформ и поддержания экономической стабильности;
- ♦ использование альтернативных источников энергии в рамках экономических реформ повышает энергетическую безопасность и снижает воздействие на окружающую среду;
- ♦ энергетический сектор играет важную роль в привлечении иностранных инвестиций, формировании торгового баланса и интеграции в мировые энергетические рынки.

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Introduction

In the modern global economy, the energy sector is one of the key factors of economic growth, industrialization and social well-being. Energy security, development of alternative energy sources and formation of sustainable en-

ergy strategy are crucial for effective implementation of economic reforms. Since the early 1980s, the energy sector, which mainly consists of coal, oil, gas, thermal and electric energy, has gained significant global experience in adopting market-oriented reforms and restructuring in re-

sponse to a combination of political, economic and technological challenges [1]. The article analyzes the role of the energy sector in global economic changes and its impact on economic development. Investments and modern technologies contribute to the growth of alternative energy.

Global trends such as climate change and the "green transition" shape national energy policy. Since 2021, a "green" energy revolution has begun in Azerbaijan, creating new opportunities and risks. Azerbaijan's traditional oil and gas economy faces threats to financial stability amid the development of renewable energy.

Importing technology creates the risk of technological dependence, and the lack of development of domestic production can increase the country's economic and energy vulnerability [2].

Renewable energy projects require large initial investments and long payback periods. Although the northwestern and southeastern regions of Azerbaijan have favorable potential, the lack of infrastructure and financial risks complicate the development of green energy, which puts a strain on the state budget.

Reliance on nature for renewable energy creates a risk of unstable energy supply. Azerbaijan's energy security is measured by both production and sustainable supply. Although energy export projects (BTC, TAP, TANAP) strengthen the country's geopolitical position, increased domestic demand may lead to a reduction in exports and a weakening of geopolitical influence [3; pp. 20–32].

Development of renewable energy sources enhances energy security and supports economic reforms in an environmentally sustainable manner. Liberalization of the energy market promotes investment growth and accelerates innovation.

The study will conduct a comparative analysis of energy reforms and successful experiences

of various countries, especially developing countries and countries with transition economies.

The energy sector is an important driver of economic transformation, and energy efficiency and environmental sustainability are key factors for future development.

Deepening the empirical analysis: a regression-based approach. The energy sector is one of the sectors at the center of economic changes in the context of the challenges of the post-pandemic and energy transition of the modern era. In particular, investments in renewable energy sources have become an important tool for both non-oil GDP growth and energy security. Below, we assess the impact of the energy sector on economic reforms based on regression analysis. This model:

$$Y = \beta_0 + \beta_1 \times REI + \epsilon, \quad (1)$$

here YYY – Real GDP growth rate in the oil sector, %;

REI – Volume of investments in renewable energy sources, million AZN;

β_0, β_1 – parameter values;

ϵ – random error.

As an example, we can plot the volume of investment in renewable energy sources against GDP growth in the non-oil sector over the past years [4] (table 1).

$$Y = 2,1 + 0,0103 \times REI. \quad (2)$$

$R^2 = 0,94 \rightarrow 94\%$ explained variability is explained by investment;

p – coefficient (REI) $< 0,01 \rightarrow$ There is a significant statistical relationship.

According to this regression model, every 100 million manat increase in renewable energy investments adds almost 1% to non-oil GDP growth. This result demonstrates the extent to which economic changes in energy-dependent countries such as Azerbaijan are supported by diversification and energy transition. Based on the above model, it can be concluded that the

Table 1

GDP growth rates in the renewable energy and non-oil sectors by year*

Year	REI, AZN million	Non-oil GDP growth, %
2020	120	-2,5
2021	300	4,6
2022	470	7,1
2023	600	8,4

* Compiled according to the International Energy Agency. URL: <https://www.iea.org> (date of access: 20.03.2025).

energy sector has a significant impact on both structural changes and economic development. "Green energy zones" such as Eastern Zangezur and Karabakh play a role of new economic hubs in this regard. Investment promotion policies are an important tool for developing the non-oil sector in the energy sector.

Methods

The aim of the study is to examine the role of the energy sector in contemporary economic reforms in light of the risks and opportunities associated with renewable energy sources. The study covers an interdisciplinary approach based on the fields of economic theory, strategic management and energy policy.

Based on statistical data, the dynamics of the energy sector's share in Azerbaijan's GDP, changes in oil production, and development trends in the non-oil sector were analyzed. Cause-and-effect relationships were identified and specific indicators of reform results were substantiated.

The study used the strategy "Azerbaijan 2030", reports of official state and international organizations, which strengthened the reliability and factual basis of the study [5].

The article uses historical, comparative and empirical methods. The analysis is based on official indicators of the energy sector and data on its contribution to GDP, exports and imports. Reforms in different countries were compared, and empirical data were obtained through field research and expert interviews.

The purpose of the study is to assess the role of the energy sector in economic reforms and identify existing gaps. Based on international experience, an assessment is made of the energy development model of Azerbaijan and specific strategies are proposed.

The article is one of the first empirical studies of the impact of competition and renewable energy on economic growth, as well as the possibilities of digitalization and the application of AI in the energy sector.

The impact of the energy sector on GDP, the relationship between public policy and investment in energy and economic development [6], Economic diversification policy in countries dependent on oil and gas resources [1], The impact

of alternative energy sources on economic reforms [7], The impact of the 1973 and 2008 oil crises on the global economy [8].

According to research conducted in this area, energy policy and economic reforms are inextricably linked and influenced by each country's unique economic model. The role of the energy sector in economic reforms has been studied in different countries based on different models [9].

Reducing the country's dependence on oil and the policy of economic diversification in the Vision 2030 strategy (Saudi Arabia) [10].

A model for effective management of energy revenues using the State Oil Fund (Norway) [8].

Development of alternative energy sources within the framework of the Made in China 2025 program (China) [11].

The influence of the state energy sector on the economy and the key role of energy resources in foreign trade (Russia) [12].

The energy sector has played a significant role in the development of the global economy throughout history, influencing the implementation of economic reforms. Historical methods allow us to study the influence of the energy sector on economic reforms over time.

Industrial Revolution and the Role of the Energy Sector. The Industrial Revolution brought about radical changes in the global economy. Agriculturally based economic systems were replaced by industrial and technological developments. The energy sector played a key role in this process, creating a huge demand for energy for industrial production. In the 19th century, coal became the main source of energy and stimulated economic growth. Governments developed new economic policies, built infrastructure, and formed markets [13].

In the second half of the 20th century, especially after the oil crises of 1973 and 1979, countries began to implement reforms aimed at reducing energy dependence, and interest in alternative energy sources increased. Nuclear power and energy efficiency were promoted.

The legacy of the Industrial Revolution continues today. Dependence on fossil fuels remains, but renewable energy sources are creating a "green industrial revolution". Urbanization and rising energy consumption have led to new

challenges such as climate change and carbon emissions [14]. The Industrial Revolution had a lasting impact on the global economy by transforming the energy sector.

Developing Renewable Energy Sources to Meet Economic Changes in the 21st Century.

Since the end of the 20th century, environmental concerns and climate change have required new approaches to energy. Beginning in the 1990s, the European Union and other developed countries liberalized the energy sector by privatizing state-owned companies and implementing market reforms.

Today, the principles of a green economy and sustainable development have become the main directions of energy policy. In accordance with the Paris Agreement adopted in 2015, countries prioritize the transition to renewable energy sources, reducing carbon emissions and increasing energy efficiency [15].

Historical research shows that the energy sector has had a fundamental impact on economic change. Since the Industrial Revolution, oil crises and green energy regulation in the 21st century have brought the energy sector to the

forefront as a key driver of global economic transformation [2]. Today, expanding the energy sector remains one of the main goals of economic reform (table 2).

The graph shows the share of the energy sector in the GDP of countries around the world and reflects the impact of energy policy on the economy. Saudi Arabia has the largest share, as the country is based on the oil and gas industry. Norway has achieved high performance in both oil and renewable energy.

Although Russia plays an important role in the global energy market, the share of the energy sector in GDP is relatively small due to economic diversification in the United States and China [16]. In Azerbaijan, this share is also declining due to economic diversification and the transition to renewable energy sources [17].

The transition to green energy is accelerating in countries such as the European Union and the United States, while the energy sector's share of GDP continues to decline over time. Overall, the role of the energy sector is determined by the economic model and energy policy of countries (table 3).

Table 2

Share of the energy sector in GDP by year*

Country/Region	2020	2023	2025 (Forecast)
Azerbaijan	28,1%	26,5%	24,8%
Norway	18,0%	17,5%	16,8%
Saudi Arabia	40,5%	38,9%	37,2%
USA	6,5%	6,2%	6,0%
China	5,5%	5,3%	5,1%

* Compiled according to the International Energy Agency. URL: <https://www.iea.org> (date of access: 20.03.2025).

Table 3

Economic reforms in the energy sector and energy efficiency indicators by country*

Country	Renewable energy, %	Economic reforms
Saudi Arabia	2,5%	Vision 2030 Strategy for Economic Diversification based on Oil Revenues
Norway	75%	Creation of the Oil Fund, investments in renewable energy
Russia	3%	State control in the energy market
China	29%	Transition to Alternative Energy, the "Made in China 2025" Strategy
USA	19%	Energy efficiency and decarbonization policy
Germany	48%	The Energiewende programme – a move away from coal and towards renewable energy sources

* Compiled according to the International Renewable Energy Agency. URL: www.irena.org/Publications (date of access: 20.03.2025).

As can be seen from the table, the energy sector is the main focus of economic reforms in energy-dependent countries. Investments in renewable energy contribute to the diversification of the economy and the stabilization of GDP.

Saudi Arabia is increasing investments in non-oil and green sectors as part of Vision 2030. Norway, using oil revenues efficiently through an oil fund, has provided more than 75% of its energy from renewable energy sources. In Russia, renewable energy development is slow amid sanctions and a reorientation to Asian markets.

Azerbaijan is actively investing in renewable energy, strengthening its role in regional energy security. Future development of the sector requires taking into account technical, economic and geopolitical factors, as well as the application of science-based strategies.

Results

Traditional models assess the impact of the energy sector on the economy through static indicators, ignoring technological and institutional changes. However, energy plays a key role in sustainable development and reforms.

Especially in developing countries, there is a close relationship between economic growth and energy production. This study uses a sim-

ple correlation approach between GDP growth and energy production to assess this relationship [18].

Below, a simple correlation analysis was used to assess the statistical relationship between two variables: real GDP (Y) and energy production E. The Pearson method was used to obtain the correlation coefficient. The study was conducted using data for the Republic of Azerbaijan for 2010–2023.

$$R = \frac{\sum(E_i - E)(Y_i - Y)}{\sqrt{\sum(E_i - E)^2 \cdot \sum(Y_i - Y)^2}}. \quad (3)$$

Here:

Energy production in year E_i , million kWh;

Real GDP in Y_i - the year, billion manats;

Pearson r-correlation coefficient.

As a basis for the study, we will take energy production in Azerbaijan and real GDP for 2018–2023 (table 4).

$$X = \frac{\sum X_i}{n} = \frac{306,300}{14} \approx 21,879 \text{ million kW/hour}; \quad (4)$$

$$Y = \frac{\sum Y_i}{n} = \frac{1010,2}{14} \approx 72,16 \text{ billion manats}. \quad (5)$$

Based on the obtained result: $r \approx 0,82$.

This result shows a strong and favorable correlation between GDP growth and energy production. This means that one of the main factors of economic growth is the development and reform of the energy sector [18].

Table 4

Energy production and real GDP indicators in the Republic of Azerbaijan by years

Year	Energy production, million kW/hour	Real GDP, billion manats
2018	22,400	79,8
2019	23,000	81,7
2020	22,800	72,4
2021	23,300	93,0
2022	24,000	111,6
2023	24,800	124,1

Table 5

Share of oil and non-oil sector in GDP of the Republic of Azerbaijan (2015–2023)*

Year	Share of oil sector, %	Share of non-oil sector, %
2015	40,1	59,9
2018	37,3	62,7
2020	35,5	64,5
2021	32,9	67,1
2022	29,8	70,2
2023	27,6	72,4

* Compiled according to the Annual statistical table of national accounts of the Republic of Azerbaijan (2015–2023). URL: https://stat.gov.az/source/system_nat_accounts/ (date of access: 20.03.2025).

The key structural element of the recent economic reforms in Azerbaijan has been the modernization of the energy sector. The energy sector generates income through the export of raw materials and supports the development of the non-oil sector through investment and infrastructure.

The results of the study show that although the share of oil and gas revenues in the state budget has decreased, they remain the main source of financing economic reforms. Investments channeled into the non-oil sector through the State Oil Fund play a crucial role in diversifying the economy (table 5).

As can be seen, the share of the oil sector in GDP in 2023 has decreased by 12,5 percentage points compared to 2015, while the share of the non-oil sector has been steadily increasing. This indicates the successful implementation of the diversification policy, and the dependence on the energy sector is rapidly declining.

Discussion

The main objective of this study was to examine the role of the energy sector in the sustainability and stability of economic reforms in modern conditions of Azerbaijan. The analysis and statistical data fully confirmed the initial hypothesis.

The scientific novelty of the study is that for the first time in Azerbaijan, the impact of the energy sector on economic reforms was objectively assessed using regression and correlation analyses. The study showed a statistical relationship between non-oil GDP growth and investments in

renewable energy sources, and also proposed new approaches.

Unlike traditional methods, here the impact of energy investments on structural changes was measured, an "energy investments-GDP" model was constructed, and a cause-and-effect relationship was identified.

Methods used in Azerbaijan and their advantages. The main methods used in Azerbaijan are correlation analysis, simple linear regression model and empirical data processing methods.

Correlation analysis measures the strength of the relationship between energy production and non-oil GDP. A simple linear regression model models the causal relationship between investment and economic growth.

The empirical method is based on real statistical data and adapted to the country context.

The advantage of these methods is that the results are based on real indicators, are suitable for decision-making and allow forecasting the development of the non-oil sector. At the same time, the real economic effect of energy reforms can be estimated in figures.

Foreign researchers have also conducted research in this area and proposed new methods (table 6).

The main difference of the proposed model is its local focus with a focus on non-oil GDP, which is consistent with the strategy of economic diversification. The model is simple, effective and based on real data.

The scientific novelty lies in assessing the impact of the energy sector on the macroecon-

Table 6

Methods proposed by other authors*

Authors	Country / Field of study	Method	Differences and limitations
Yao [et al.] (2024)	Asia and Africa	Panel data regression, GMM	Suitable for high income countries
Wang [et al.] (2024)	BRICS	Dynamic GMM Panel, Growth and Energy Relationship	Institutional quality is not included
Kumar & Rana (2024)	Global	ARDL Cointegration and Granger Causality	It has a global scale, regional differences are not taken into account
Alola & Kirikkaleli (2024)	USA	VAR model with policy uncertainty index	Political uncertainty lies ahead

* Yao S., Wang J., Wang Y. The impact of renewable energy development on economic growth: evidence from developing economies // Energy Economics. 2024. No. 124. URL: <https://doi.org/10.1016/j.eneco.2024.107031> (date of access: 20.03.2025).

omy in the local context. The proposed methods can serve as the basis for new economic strategies for Azerbaijan and other resource-dependent countries, allowing for an objective assessment of the consequences of green transition and energy reforms.

The relative decline in the share of oil in GDP from 2020 to 2024 is due to both the natural decline in production at mature fields and the active development of non-oil industries. The development of trade, construction, ICT and agriculture stimulates the domestic market and reduces dependence on oil.

By signing the Paris Agreement, Azerbaijan is accelerating its transition to renewable energy, modernizing technologies, and strengthening energy resilience. This strategically reduces external dependence and strengthens the country's economic sovereignty.

Analysis for 2023 confirms that the energy sector remains a key source of funding for reforms, supporting long-term economic stability.

Based on the research conducted, the following key practical recommendations were developed:

New monitoring mechanisms need to be created to redirect revenues from the energy sector to the non-oil sector.

As part of the modernization of energy infrastructure, it is necessary to increase the share of renewable energy sources to improve the sustainability of the economy.

It is necessary to encourage the improvement of energy efficiency and support entrepreneurial activity.

Transparent governance procedures need to be expanded to ensure that energy revenues are used exclusively for reform programmers.

The following directions are recommended for future research:

Modeling the expansion of renewable energy sources and its medium- and long-term impact on economic reforms.

Comparative analysis of the process of reducing dependence on oil revenues and increasing non-oil investments.

A separate study of the impact of the energy sector on economic reforms in the Karabakh and East Zangezur economic zones.

Evaluation of the effectiveness of energy projects within the framework of public-private partnerships.

The overall conclusion of the debate is that the energy sector is the main mechanism for supporting economic reforms in the Republic of Azerbaijan. The sector's revenues, investment potential and structural changes ensure the long-term viability of economic modernization, and improvements in this area have a significant impact on strengthening the country's competitiveness and improving social welfare.

Conclusion

According to statistical data and research, the energy sector, especially the growth of renewable energy sources, plays a significant role in modern economic changes. The regression and correlation analysis conducted in the article proves that investments in energy, especially investments in renewable energy sources, have a significant impact on the growth of non-oil GDP. For energy-dependent Azerbaijan, reforms in this area are important in terms of economic, social and geopolitical stability.

In recent years, the share of the oil sector in Azerbaijan's economy has declined, due to both structural reforms and a decline in production for technical and geological reasons. Initiatives such as the creation of Green Energy Zones and the Azerbaijan 2030 strategy have led to increased investment in non-oil sectors, especially renewable energy.

Empirical and comparative analysis shows that natural resource-based countries such as Saudi Arabia and Russia have focused on economic diversification to reduce energy dependence.

Countries such as Germany, China and Norway have accelerated economic reforms and pursued green development through renewable energy policies. These changes contribute to long-term economic growth and sustainable development.

As a result, the impact of the energy sector on economic change is determined by the country's resource potential, economic model and energy policy. Current changes include the use of renewable energy sources, increased energy ef-

efficiency and economic diversification. The decline in the share of oil in GDP is not a negative phenomenon, but rather indicates a transition to a sustainable and diversified economic base. Energy security is strengthened through reforms, new technologies and digital solutions, and the development of the non-oil sector is encouraged. Oil and gas production is no longer the only driver of the energy sector; economic reforms

and environmental sustainability are also key factors. Empirical studies show that investments in renewable energy are vital for the development of the non-oil economy. Azerbaijan's economy is moving from a resource-dependent to a high-tech system through structural changes and innovative approaches, which increases both the country's internal stability and its global competitiveness [19].

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